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PHOTOPERIOD AND TEMPERATURE INFLUENCES ON EGG NUMBER IN *BRACHYMERIA INTERMEDIA* (HYMENOPTERA: CHALCIDIDAE), A PUPAL PARASITOID OF *LYMANTRIA DISPAR* (LEPIDOPTERA: LYMANTRIIDAE)[1]

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Abstract.—Oosorption in *Brachymeria intermedia* (Nees) is photoperiodically induced by a short photophase. Low temperatures enhance the effects of photoperiod. Oocyte resorption proceeded more quickly at lower temperatures. Preconditioning of immature stages within its host or of young adults has an effect on rate of oocyte resorption.

Insects exhibit a variety of reproductive mechanisms including viviparity. ovoviviparity, oviparity, etc. In many species, particularly in parasitoid species, the timing of oviposition is critical. Appropriate timing of oviposition and conservation of nutrients may be enhanced by oosorption. Oosorption is a process characterized by cessation of vitellogenesis and degeneration of the vitellogenic ooctye within the ovary. It has been associated with various life history phenomena as an energy conserving reproductive strategy. That is, resorption is an adaptive mechanism which occurs when oviposition would waste energy. Resorption of oocytes in diapausing females has been described in a number of species including an ichneumonid parasitoid. It is also found in insects avoiding adverse conditions, characterized by low temperature or short day photoperiods (Bell and Bohm 1975).

The reproductive system of *Brachymeria intermedia* (Nees), a European pupal parasitoid of the gypsy moth, is typically hymenopteran (D'Rozario 1942), containing two ovaries each of which is comprised of three polytrophic ovarioles (Dowden 1935, Engleman 1970). A mature ovariole will usually hold one chorionic and one or two other vitellogenic oocytes. Thus, *B. intermedia* is a synovigenic species with monootene ovarioles where ovulation is externally induced (Flanders 1950). Flanders (1950) suggested that hymenopteran parasitoids that have synovigenic females are more likely to

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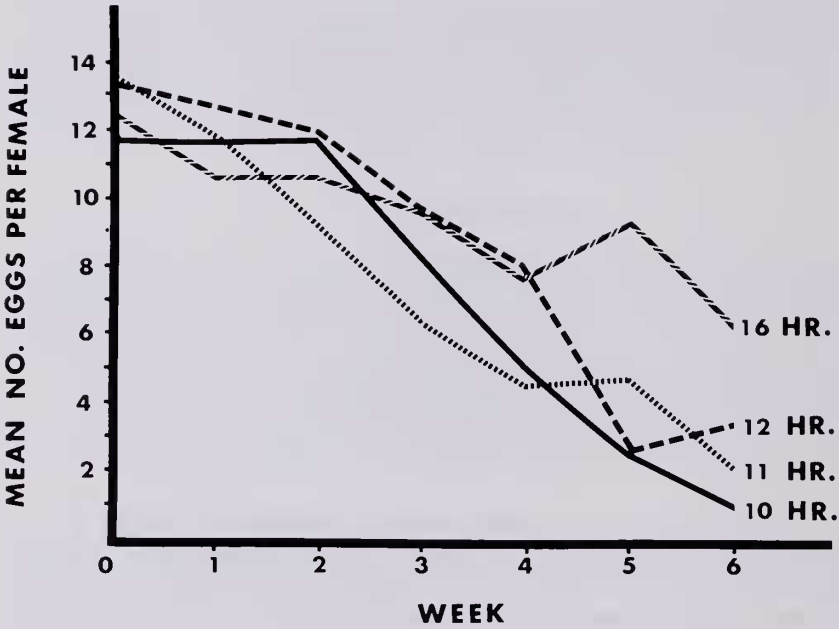

Fig. 1A. The influence of photoperiod on the average number of vitellogenic eggs in *B. intermedia.**

be effective biological control agents, in part, because ovigenesis and oosorption are not totally host dependent. This study details the role of photoperiod and temperature on oosorption in *B. intermedia.*

Materials and Methods

B. intermedia were reared on wax moth pupae (*Galleria mellonella*), a standard laboratory host. Upon emergence, adults were maintained in 30 × 30 cm cages at 16 hr L:8 hr D, 50% R.H. and 21.1°C for two weeks before being used in experiments. In the laboratory, the achievement of reproductive maturity in females is variable but in general, females are mature after about 7 days. For each set of experimental conditions in each experiment groups of 80 females and 25 males were placed in a cage and provided with honey, distilled water and paper strips (resting sites).

Data on the initial state of the female reproductive system (week 0) was obtained by removing 10 females for dissection. On each of 6 successive weeks 10 females were dissected to determine the state of ovarian development. Each dissection involved the removal of the intact ovaries. Both the total number of opaque (vitellogenic) eggs and the number of terminal

* Each data point represents the average egg number of the population sample dissected for any given week.

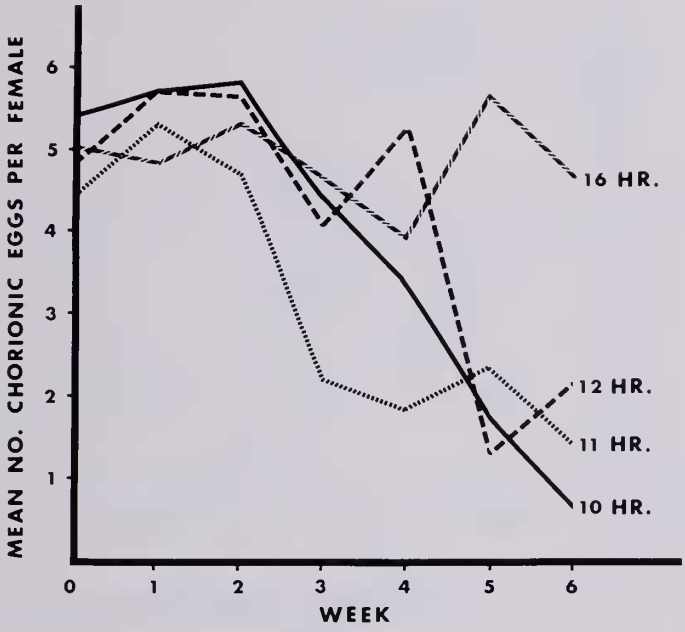

Fig. 1B. The influence of photoperiod on the average number of chorionic eggs in *B. intermedia*.*

oocytes which were larger than 0.33 mm in length were recorded. The final stages of oocyte resorption were characterized by the disappearance of lipid yolk spheres. In order to characterize more fully the state of oocyte development, ovaries dissected in the 10 hr and 16 hr photophase experiments (see below) were stained with trypan blue for 20 minutes at 23°C (Telfer and Anderson 1968). This dye is an accurate index of the change from normal vitellogensis to oosorption, based on alteration of the oocyte membrane.

Week numbers refer to the number of weeks in which the wasps were kept under experimental conditions. Experiments were conducted in environmental control chambers which provided 50% R.H. and photoperiods and temperatures appropriate to each set of experiments.

To demonstrate the influence of photoperiod on oosorption, adults were exposed to 21.1°C and the following photophases: 10, 11, 12, 16 hr. The influence of exposure to short photoperiod prior to adult reproductive maturity was also investigated. Wasps were reared in their pupal host and kept after adult parasitoid emergence for 2 weeks in a 12 hr photophase and 21.1°C and compared to those kept in a 16 hr photophase and 21.1°C for the same period. Finally, three cohorts of adults were kept each at an 11 hr

* Each data point represents the average egg number of the population sample dissected for any given week.

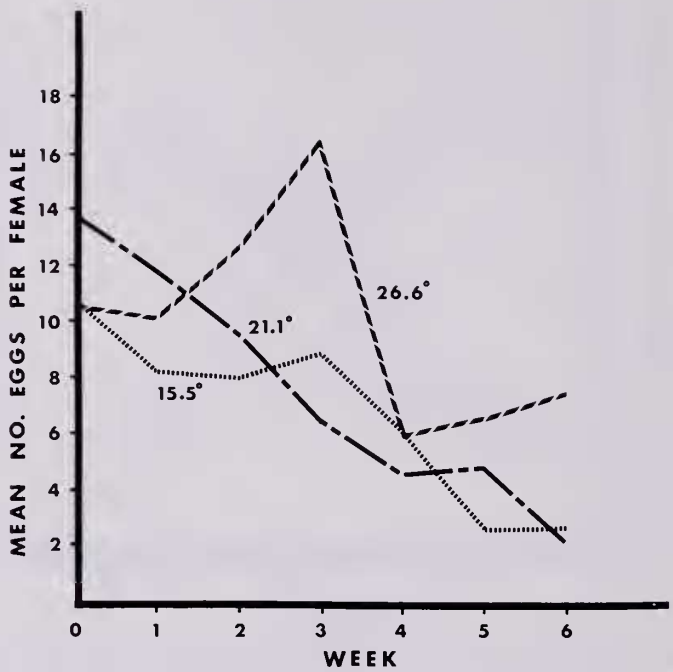

Fig. 2. The influence of temperature on the average number of vitellogenic eggs in *B. intermedia*.*

photophase and at 15.5°C, 21.1°C or 26.6°C to investigate temperature effects on oosorption.

Analyses of variance and Duncan's new multiple range tests were performed to determine significant differences in the data.

Results and Discussions

Oosorption in *B. intermedia* is affected by photoperiod. (Figs. 1A, B). That oosorption ensued in adults placed in a short photophase (10, 11, 12 hr) compared to those in long photophase (16 hr) is demonstrated by the decreasing egg numbers through the six weeks of the experiments ($P < 0.01$). Adults kept in a long photophase showed a less dramatic decline in oocyte number compared to short photophase (10, 11 and 12 yr). The overall trend in total number of oocytes (Fig. 1A) is similar to that of number of chorionic eggs (Fig. 1B). This concurrence is found in all subsequent experiments and thus, no other data on chorionic eggs are presented. From

* Each data point represents the average egg number of the population sample dissected for any given week.

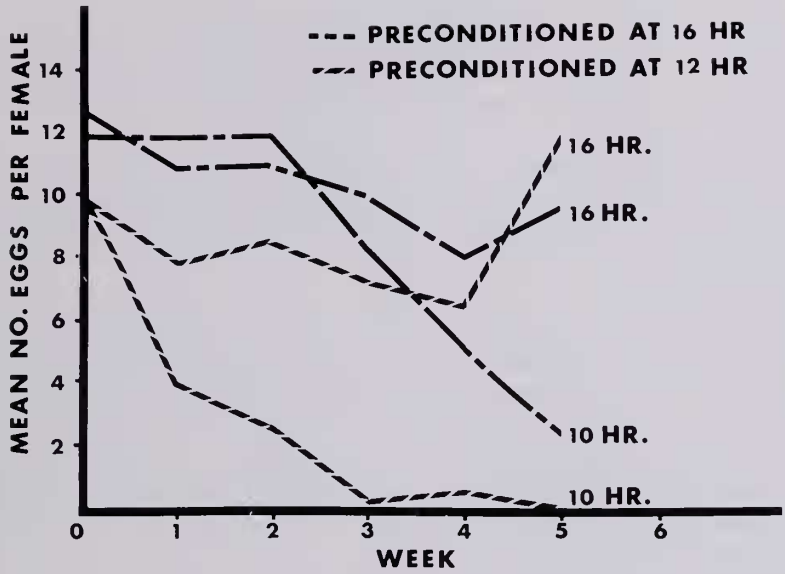

Fig. 3. The influence of photoperiod on the average number of vitellogenic eggs in immature and young adult *B. intermedia* (<2 weeks old.)*

weeks 0 to 6 the relationship between treatment means, for any given week, varies. This is due, in part, to the fact that weekly dissections necessitate the use of a new cohort of adults each week.

Adult female parasitoids have been reported to partially absorb eggs in the absence of hosts (Flanders 1950). Although greater resorption has been observed in older females, no quantitative study of the effect of age on resorption is yet available (Bell and Bohm 1975). Thus, although age (6 weeks) and absence of hosts may enhance oosorption, short photoperiod does have a direct effect on oosorption since adults at long photoperiod were of comparable age and they experience a similar lack of hosts in our experiments.

Low temperatures enhanced the effect of short photophase (Fig. 2). Oocyte resorption proceeded more quickly at lower temperatures as indicated by comparison of mean values at each temperature ($P < 0.01$). This is significant, particularly, since physiological processes generally advance more rapidly at higher temperatures.

The two series of experiments discussed above demonstrate the sensitivity of 2-week and older females to photoperiod and temperature. Exposure

* Each data point represents the average egg number of the population sample dissected for any given week.

of immature stages of *B. intermedia* (within its host) and of young adults (<2 weeks old) to short daylength had marked consequences on their ovarian development (Fig. 3). Adults preconditioned at a 12 hr photophase before being placed in a 10 or 16 hr photophase generally had fewer oocytes with yolk at week 0 than those preconditioned at a 16 hr photophase ($P < 0.01$). Those adults placed in a short photophase (10 hr) had totally resorbed ovaries laden with fatty tissues by week 5. Those placed in long daylength (16 hr) maintained a higher mean no. of eggs per female compared to adults in a short photophase.

Females are the overwintering stage of *B. intermedia*. Short-day photoperiods and low temperatures characterize pre-overwintering conditions, when few, if any, hosts are available to *B. intermedia*. Oosorption of oocytes under these conditions (short photophase and low temperature) would represent a logical adaptive mechanism to conserve nutrients critical to the overwintering (diapausing) female. Indeed in 1942, Flanders stated that in the parasitic Hymenoptera the occurrence of oosorption is an adaptation for maintaining the reproductive capacity when environmental conditions are unfavorable for oviposition.

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Literature Cited

Bell, W. A. and M. K. Bohm. 1975. Oosorption in insects. Biol. Rev. 50:373–396.

Dowden, P. B. 1935. *Brachymeria intermedia* (Nees), a primary parasite and *B. compsilurae* (Cwfd.) a secondary parasite of the gypsy moth. J. Agric. Res. 50:495–523.

D'Rozario, A. M. 1942. On the development and homologies of the genitalia and their ducts in Hymenoptera. Trans. Roy. Ent. Soc. 92:363–415.

Engelmann, F. 1970. The Physiology of Insect Reproduction. Pergamon Press, Oxford.

Flanders, S. E. 1942. Oosorption and ovulation in relation to oviposition in the parasitic Hymenoptera. Ann. Ent. Soc. Am. 35:251–266.

———. 1950. Regulation of ovulation and egg disposal in the parasitic Hymenoptera. Can. Ent. 82:134–140.

Telfer, W. J. and L. M. Anderson. 1968. Functional transformations accompanying the initiation of a terminal growth phase in the cercropia moth oocyte. Devel. Biol. 17:512–535.

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